PREVALENCE OF OSTEOPENIA AND OSTEOPOROSIS: THE ASSESSMENT OF OSTEOPOROSIS KNOWLEDGE, HEALTH BELIEF AND SELF-EFFICACY AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS IN PENANG

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By

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LIST OF ABBREVIATIONS & SYMBOLS

AVE	Average Variances Extracted
AGFI	Adjusted Goodness-Of-Fit Index
AMOS	Analysis of Moment Structures
AGE	Advanced Glycation End Products
ACE	Angiotensin Converting Enzyme Inhibitor
ANOVA	One Way Analysis Of Variance
ANCOVA	Analysis Of Covariance
AUC	Area Under the Curve
BMD	Bone Mineral Density
BMI	Body Mass Index
BP	Blood Pressure
BUA	Broadband Ultrasound Attenuation
CR	Composite Reliability
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CRC	Clinical Research Centre
CVR	Content Validity Ratio
CVI	Content Validity Index
CVD	Cardiovascular Disease
cm	Centimetre
CI	Confidence Interval
DXA	Dual-Energy X-Ray Absorptiometry
DM	Diabetes Mellitus

DBP	Diastolic Blood Pressure
dB/MHz	decibels/megahertz
eBMD	Estimate Bone Mineral Density
EFA	Exploratory Factor Analysis
FBS	Fasting Blood Sugar
g/cm^2	Grams per Square Centimetre
GFI	Goodness Of Fit Index
HDLC	High-Density Lipoprotein Cholesterol
HbA1c	Glycosylated Haemoglobin
HBM	Health Belief Model
HPP	Hospital Pulau Pinang
HC	Hip Circumference
IDF	International Diabetes Federation
IHD	Ischaemic Heart Disease
IGF	Insulin-Like Growth Factor
kHz	Kilohertz
kg/m^2	kilogram per square metre
KMO	Kaiser-Meyer-Olkin
LDLC	Low-Density Lipoprotein Cholesterol
LBMD	Low Bone Mineral Density
LR	Likelihood Ratio
MREC	Medical Research and Ethics Committee
mmol/L	millimoles per Liter
mg/dL	milligrams/deciliter
MHz	Megahertz

M±SD	mean±standard deviations
m/s	meters/second
MLR	Multivariate Multinomial Logistic Regression
NHMS III	The Third National Health And Morbidity Survey
NOF	National Osteoporosis Foundation
NPV	Negative Predictive Value
OR	Odds Ratio
OKT	Osteoporosis Knowledge Test
OHBS	Osteoporosis Health Belief Scale
OSES	Osteoporosis Self-Efficacy Scale
OKT-M	Osteoporosis Knowledge test Malay version
OHBS-M	Osteoporosis Health Belief Scale Malay version
OSES-M	Osteoporosis Self-Efficacy Scale Malay version
PASW	Predictive Analytics Software
PBM	Peak Bone Mass
PVD	Peripheral Vascular Disease
PNFI	Parsimonious Normed Fit Index
PGFI	Parsimony Goodness Of Fit Index
PPV	Positive Predictive Value
%	Percent
QUS	Quantitative Ultrasound Scan
RDI	Recommended Daily Intake
ROC	Receiver Operating Characteristic
RMSEA	Root Mean Square Error Of Approximation
RM	Ringgit Malaysia

SI	Stiffness Index
SOS	Speed of Sound
SD	Standard Deviations
SBP	Systolic Blood Pressure
SCT	Social Cognitive Theory
SME	Subject-Matter-Experts
SEM	Structural Equation Modelling
TLI	Tucker-Lewis Index
TC	Total Cholesterol
TG	Triglyceride
T1DM	Type 1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus
T.V	Television
UKPDS	United Kingdom Prospective Diabetes Study
USM	Universiti Sains Malaysia
U.S.	United State
UK	United Kingdom
UAE	Urinary Albumin Excretion
WHO	World Health Organisation
WC	Waist Circumference
WHR	Waist to Hip Ratio

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2. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2013). Psychometric properties of osteoporosis knowledge tool and self-management behaviours among Malaysian type 2 diabetic patients. *Journal of Community Health*. **38** (1), 95-105. **(Impact Factor: 1.293)**.

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International Conferences

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PREVALENS DARIPADA OSTEOPENIA DAN OSTEOPOROSIS: PENILAIAN TENTANG PENGETAHUAN, KEPERCAYAAN KESIHATAN DAN KECEKAPAN DIRI TERHADAP OSTEOPOROSIS DALAM KALANGAN PESAKIT DIABETES MELLITUS JENIS 2 DI PULAU PINANG

ABSTRAK

Kedua-dua diabetes mellitus jenis 2 (T2DM) dan osteoporosis adalah suatu keadaan yang kronik dan perkaitan di antara kedua-duanya juga amat kompleks. Pengetahuan, kepercayaan kesihatan dan kecekapan diri terhadap osteoporosis adalah asas kepada semua program pengurusan osteoporosis dan ia juga merupakan prasyarat bagi memulakan perubahan tingkah laku. Justeru, matlamat kajian ini adalah untuk menilai prevalens keadaan osteoporotik dan tahap pengetahuan, kepercayaan kesihatan dan kecekapan diri terhadap osteoporosis dalam kalangan pesakit T2DM di Pulau Pinang.

Instrumen yang digunakan untuk menilai tahap pengetahuan, kepercayaan kesihatan dan kecekapan diri terhadap osteoporosis adalah ujian pengetahuan osteoporosis (OKT), skala kepercayaan kesihatan osteoporosis (OHBS) dan skala kecekapan diri osteoporosis (OSES), masing-masing. Sampel seramai 250 orang pesakit dipilih daripada klinik pesakit luar diabetes di Hospital Pulau Pinang (HPP) bagi mengesahkan ketiga-tiga skala tersebut (OKT-M, OHBS-M dan OSES-M) dalam konteks versi di Malaysia. Suatu prosedur standard '*forward-backward*' digunakan

untuk menterjemah skala ke dalam bahasa Melayu. Kebolehpercayaannya diuji bagi kekonsistenan dalam dan kesahihan disahkan dengan menggunakan muka, kandungan dan kesahihan binaan. Keputusan menunjukkan bahawa kebolehpercayaan dan kesahihan adalah boleh diterima. Di samping itu, analisis keluk ROC (ciri operasi penerima) digunakan untuk menentukan nilai-potongan (cut-off value) bagi OKT-M, OHBS-M dan OSES-M dengan kesensitifan dan kespesifikan yang optimum untuk membezakan di antara pengetahuan, kepercayaan kesihatan dan kecekapan diri, yang tinggi dan rendah terhadap osteoporosis. Nilai-potongan OKT-M, OHBS-M dan OSES-M adalah 14, 169, dan 858, masing-masing. Kajian ini merumuskan bahawa OKT, OHBS and OSES adalah sah dan boleh dipercayai dan boleh digunakan dalam konteks pesakit diabetes di Malaysia.

Sampel seramai 450 orang pesakit T2DM dipilih daripada klinik pesakit luar diabetes di HPP untuk menilai status kesihatan tulang melalui pengukuran BMD (ketumpatan mineral tulang) menggunakan QUS, dan juga untuk menilai pengetahuan, kepercayaan kesihatan dan kecekapan diri terhadap osteoporosis. Berdasarkan QUS, prevalens BMD normal, osteopenia dan osteoporosis adalah 18%, 59.8% dan 22.2%, masing-masing.

Di samping itu, dapatan kajian menunjukkan bahawa 66.70%, 85.60% dan 71.30% daripada pesakit T2DM mempunyai tahap yang rendah bagi pengetahuan, kepercayaan kesihatan dan kecekapan diri, masing-masing. Tambahan pula, perkaitan yang signifikan ditemui di antara skor QUS-T, pengetahuan, kepercayaan kesihatan dan kecekapan diri terhadap osteoporosis. Keputusan menunjukkan bahawa skor QUS (BMD normal, osteopenia dan osteoporosis) secara subjektif

ditentukan melalui gabungan faktor kognitif dan tingkah laku, dan juga data sosiodemografi. Peramal bebas mempunyai perkaitan yang secara statistik adalah signifikan untuk membezakan kumpulan osteopenia dan osteoporosis daripada BMD normal adalah tempat tinggal, indeks jisim badan (BMI), gender, OKT-M, OSES-M dan sejarah keluarga berkenaan dengan patah/ fraktur. Selain itu, umur dan nilai HbA1c (kawalan glisemik) adalah ramalan hanya untuk osteoporosis. Hasil kajian ini adalah amat penting kerana ia dinyatakan faktor-faktor yang meramalkan keadaan osteoporosis dan membantu untuk memulakan tingkah laku pencegahan osteoporosis.

Dirumuskan bahawa skor QUS dapat dikaitkan dan terkesan oleh banyak faktor dalam kalangan pesakit T2DM. Justeru, penyedia penjagaan kesihatan sepatutnya memberi tumpuan yang khusus terhadap populasi berisiko tinggi apabila mempertimbangkan tentang pengurusan osteoporosis. Usaha gigih perlu diambil untuk meningkatkan pengetahuan. kepercayaan perubatan dan kecekapan diri terhadap osteoporosisi bagi tingkah laku pencegahan osteoporosis yang berkesan. Dapatan kajian menunjukkan bahawa penilaian kesihatan tulang, pengetahuan. kepercayaan perubatan dan kecekapan diri pesakit terhadap osteoporosis adalah penting dan secara tidak langsung mencerminkan program pendidikan yang diperlukan pada masa depan untuk meningkatkan pengurusan osteoporosis.

PREVALENCE OF OSTEOPENIA AND OSTEOPOROSIS: THE ASSESSMENT OF OSTEOPOROSIS KNOWLEDGE, HEALTH BELIEF AND SELF-EFFICACY AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS IN PENANG

ABSTRACT

Type 2 diabetes mellitus (T2DM) and osteoporosis are both chronic conditions and the relationship between them is complex. Knowledge, health belief and self-efficacy toward osteoporosis are fundamental to all osteoporosis management programs and are often a pre-requisite for initiating desired behavioural changes. Therefore, the aims of the present study were to assess the prevalence of osteoporotic conditions and the level of knowledge, health belief and self-efficacy toward osteoporosis among T2DM patients in Penang.

The most widely used instruments to assess knowledge, health belief and self-efficacy toward osteoporosis are the osteoporosis knowledge test (OKT), osteoporosis health belief scale (OHBS) and osteoporosis self-efficacy scale (OSES), respectively. Thus, a sample of 250 patients was conveniently recruited from the outpatient diabetes clinic at Hospital Pulau Pinang (HPP) for the purpose of validation of Malaysian versions of these three scales (OKT-M, OHBS-M and OSES-M). A standard "forward-backward" procedure was used to translate the scales into the Malay language. Reliability was tested for internal consistency and

validity was confirmed using face, content and construct validity. The results showed acceptable reliability and validity. In addition, the receiver operating characteristic (ROC) curve analysis was used to determine cut-off values for OKT-M, OHBS-M and OSES-M with the optimum sensitivity and specificity to distinguish between high and low osteoporosis knowledge, health belief and self-efficacy, respectively. The cut-off values of OKT-M, OHBS-M and OSES-M were 14, 169 and 858, respectively. This part of the study concluded that OKT, OHBS and OSES were valid and reliable and can be used among patients with diabetes in the Malaysian setting.

A convenient sample of 450 T2DM patients were recruited from the outpatient diabetes clinic at HPP to assess the bone health status by measuring the bone mineral density (BMD) using quantitative ultrasound scan (QUS), as well as to evaluate osteoporosis knowledge, health belief and self-efficacy. According to QUS, the prevalence of normal BMD, osteopenia and osteoporosis were 18%, 59.8% and 22.2%, respectively.

In addition, the study findings revealed that 66.70%, 85.60% and 71.30% of T2DM patients had a low level of osteoporosis knowledge, health belief and self-efficacy, respectively. Moreover, significant associations were found between the QUS T-scores, osteoporosis knowledge, health belief and self-efficacy. The results showed that QUS scores (normal BMD, osteopenia and osteoporosis) were subjectively determined by a combination of cognitive and behavioural factors, as well as socio-demographic data. The independent predictors that had a statistically significant relationship to distinguish the osteopenia and osteoporosis groups from normal BMD

were living place, body mass index (BMI), gender, OKT-M, OSES-M and family history of fracture. Moreover, age and HbA1c value (glycaemic control) were predictors only for osteoporosis. The results of this study were of great importance as it specified the factors that predict osteoporotic conditions and help to initiate osteoporosis preventive behaviours.

It is concluded that QUS scores were associated and affected by many factors in T2DM patients; therefore, healthcare providers should pay attention to those high risk populations when considering osteoporosis management. Extra effort is required to improve patients' knowledge, health belief and self-efficacy toward osteoporosis for effective osteoporosis prevention behaviour. The study findings revealed that the assessment of T2DM patients' bone health, knowledge, health belief and self-efficacy toward osteoporosis are crucial and highlight the required future educational programs to improve osteoporosis management.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

1.1.1 Osteoporosis

The major contributors to the increase in the rate of chronic disease are an aging population as well as a sedentary and unhealthy lifestyle (Bodenheimer *et al.*, 2009). The number of people with multiple chronic illnesses is expected to increase from 57 million in 2000 to 81 million by the year 2020 (Horton, 2009). In addition, more than three quarters of all health Medicare expenditure spending is for people with chronic conditions (Anderson and Horvath, 2004, Horton, 2009).

Osteoporosis is a chronic disease that represents a major serious public health concern due to its prevalence worldwide. Osteoporosis is the most common bone disease characterised by low bone mass, microarchitectural deterioration of bone tissue, compromised bone strength, and enhanced bone fragility, consequently predisposing an individual to an increased risk of fracture (Bouillon *et al.*, 1991, Kanis *et al.*, 1994). According to the World Health Organisation (WHO) diagnostic classification, osteoporosis is defined as a bone mineral density (BMD) value less than or equal to 2.5 standard deviations below the mean BMD of the young adult reference population (World Health Organization, 2003). Almost two-thirds of those who survive a fracture remain disabled and only 25% will resume normal activities (Jensen and Bagger, 1982, Cummings *et al.*, 1985, Clayer and Bauze, 1989).

Osteoporosis affects an enormous number of people worldwide. More than 200 million people have osteoporosis, regardless of race and gender, and its incidence will continue to rise as the population ages (Cooper, 1999). In the United States (U.S.), by the year 2002, it was estimated that more than 10 million individuals over the age of 50 will have osteoporosis and an additional 34 million individuals are at risk of having low bone mass and osteoporosis related-fractures (Cooper, 1999, National Osteoporosis Foundation, 2002, Holroyd *et al.*, 2008). By 2020, these numbers are estimated to rise to approximately 14 million individuals with osteoporosis and more than 47 million cases of low bone mass, as the population ages (U.S. Department of Health Human Services, 2004, Lane, 2006, National Osteoporosis Foundation, 2013).

Osteoporosis is primarily a woman's disease, especially postmenopausal women (Reginster and Burlet, 2006). In the U.S., eight million American women were estimated to have osteoporosis; women are usually more susceptible to osteoporosis as they lose approximately 20% of their bone mass in the first 5-7 years after menopause (U.S. Department of Health Human Services, 2004, Dempster, 2011). In the U.S. and the European Union, osteoporosis is found in 30% of all postmenopausal women, and it is expected that more than 40% of postmenopausal women will experience a fracture in later life (Melton *et al.*, 1992). Although osteoporosis is more prevalent in women, it can also affect men (Melton 2001). The incidence of osteoporosis also increases in men as they get older, with approximately 2 million American men affected with this disease (U.S. Department of Health Human Services, 2004).

With regard to ethnicity and osteoporosis risk, 20% of Caucasian, 20% of Asian, 10% of Hispanic and 5% of African-American women over the age of 50 years have osteoporosis. Moreover, 52%, 52%, 49% and 35% of these women, respectively, have low bone mass and are at risk of developing osteoporosis (National Osteoporosis Foundation, 2013). However, Caucasian and Asian women still bear the immense global burden of osteoporosis (U.S. Department of Health Human Services, 2004).

Osteoporosis is considered as a silent disease (as it occurs without symptoms) and is usually undetected until fracture occurs. All fractures are associated with considerable morbidity, lower quality of life, long-term disability (including pain, height loss and inability to stand and walk), as well as increased mortality (Barrett-Connor, 1995, Salkeld *et al.*, 2000, National Institutes of Health, 2001, Colon and Saag, 2006). Thus, fractures are the biggest and the most devastating complication facing most individuals with osteoporosis (Leibson *et al.*, 2002, Dempster, 2011). Worldwide, it is estimated that there were about 1.7 million osteoporosis-related fractures in 1990 and this figure is expected to rise to 2.6 million by the year 2025 (Gullberg *et al.*, 1997, Johnell and Kanis, 2004, U.S. Department of Health Human Services, 2004). Moreover, osteoporosis-related fractures account for 0.83% of non-communicable disease in terms of global burden. The greatest proportion of osteoporosis-related fractures are found in Europe (36.6%), whereas Southeast Asia (15.5%) and North and South America (16.0%) have a lower prevalence (Johnell and Kanis, 2006).

In the U.S., the estimated costs of the potential consequences of osteoporosis and osteoporosis-related fractures were between $13.7 and $20 billion in 2005; this figure is expected to rise to more than $25 billion by 2025 with over 3 million fractures as the population ages (Burge *et al.*, 2007, Watts *et al.*, 2010). Moreover, one year after fracture surgery, individuals' annual medical costs are estimated to be $14,600 (Gabriel *et al.*, 2002). In the United Kingdom (UK), the medical costs of osteoporosis and fractures are expected to be approximately £615 million annually (Kanis and Pitt, 1992).

Although the risk of developing osteoporosis is highest in North America and Europe, it is expected to rise more in Asian countries as the population ages (Genant *et al.*, 1999). The Asian Osteoporosis Study (AOS), which was the first extensive study conducted in Asia, showed that the incidence of hip fracture in Hong Kong and Singapore was similar to an American Caucasian population (Lau *et al.*, 2001b). A recent Asian study showed an increase in mortality risk of hip fracture that persisted for 5 years after fracture in both men and women (Koh *et al.*, 2013). In Asia, according to the WHO, it was expected that the number of people aged over 65 years will be approximately 900 million by the year 2050. Consequently, the figures for hip fracture in Asian countries is expected to rise from 30% in 1990 to more than 50% by the year 2050, with approximately 3.2 million people affected annually (Cooper *et al.*, 1992, Gullberg *et al.*, 1997, Lau, 2002).

1.1.2 Diabetes mellitus

In recent decades, the ability to diagnose and treat diabetes mellitus by medical professionals has greatly grown with an increase in medical knowledge and new

technologies. However, the effectiveness of this growth is challenged by the requirement for patients to change their behaviour. Diabetes mellitus (DM), along with other chronic diseases such as cardiovascular diseases (CVD), cancer and mental illnesses, now accounts for approximately 47% of the global health burden of disease and more than half of all deaths (Darnton-Hill *et al.*, 2004, Wild *et al.*, 2004).

Diabetes is mounting health problem in the contemporary era and its prevalence is increasing continuously with a high degree of co-morbidity and mortality (Beckley, 2006, Hu, 2011). According to the International Diabetes Federation (IDF)**,** approximately 366 million people are diabetic and this number is expected to rise to approximately 552 million by the year 2030 (Whiting *et al.*, 2011). Moreover, there is an increasing in the number of people with impaired glucose tolerance from 344 million in 2010 to 472 million expected by the year 2030 (Hu, 2011). Moreover, it was determined that diabetes mellitus accounted for 12% of worldwide total healthcare expenditures, or approximately $376 billion in 2010, and this figure is expected to reach $490 billion by the year 2030 (Zhang *et al.*, 2010). Type 2 diabetes mellitus (T2DM) accounts for about 90% of the cases of diabetes and is more likely to occur in developing countries due to a sedentary lifestyle, aging, obesity and poor dietary habits (Darnton-Hill *et al.*, 2004). In addition, most people with diabetes cases live in low- and middle-income countries (Hu, 2011).

Diabetes can affect any person of either gender, at any age from any race or socio-economic background; however, Asian are affected more than Caucasians (Hu, 2011). In Asia, diabetes accounts for more than 60% of the diabetic population worldwide as a consequence of rapid economic growth, urbanisation and nutritional

transitions status (Chan *et al.*, 2009). Asians develop diabetes at lower degrees of obesity and at younger ages, which means that they suffer longer from complications and die sooner than people from other regions (Ko *et al.*, 1999, Yoon *et al.*, 2006, Chan *et al.*, 2009). Thus, the prevalence of diabetes in this racially heterogeneous population with different demographic, cultural and socio-economic backgrounds has rapidly increased among urban and younger people (Wild *et al.*, 2004, Yoon *et al.*, 2006, Ramachandran *et al.*, 2010, Shaw *et al.*, 2010).

Countries undergoing substantial socio-economic growth and urbanisation are more likely to show an increase in the prevalence of diabetes, and data from an epidemiological study in Asia has attracted considerable attention to this problem (Ramachandran *et al.*, 2010). Urban lifestyles are associated with a lower level of physical activity and increased diversity in the diet with more unsaturated and total fats and a lower intake of fibre. Chronic diseases like diabetes are diet-related, and the effect of poor dietary habits is significant to the aetiology of these diseases (Chan *et al.*, 2009). This may lead to a rapid increase in diabetes prevalence within a relatively short time. For example, in China, the prevalence of diabetes is expected to rise from less than 1% in 1980 to 10% by the 2008, with more than 92 million diabetes patients and 148 million people in a prediabetic status (Yang *et al.*, 2010b). These results suggest that China has overtaken India and become the global diabetes epidemic epicentre. However, in urban areas in the south of India, the prevalence of diabetes has reached nearly 20% (Ramachandran *et al.*, 2008).

1.2 Osteoporosis and diabetes mellitus in Malaysia

1.2.1 Osteoporosis in Malaysia

Osteoporosis is considered to be one of the most prevalent and costly diseases across Asia, as the population is rapidly increasing and aging (Yeap *et al.*, 2013). The prevalence of osteoporosis increases markedly after the age of 50 in postmenopausal women in Asia (Kim *et al.*, 2000, Lin *et al.*, 2001, Jang *et al.*, 2006). In Malaysia, the prevalence of osteoporosis in postmenopausal women was reported as 24.10% in 2005, although the prevalence of osteoporosis was much lower in Thailand (12.60%), China (16.10%) and Taiwan (10.08%) (Lin *et al.*, 2001, Jang *et al.*, 2006, Loh and Shong, 2007). Overall, Asian countries have a higher prevalence of osteoporosis than western countries, which may be attributed to the fact that the Asian population has a lower body mass index, weight and shorter height (Babbar *et al.*, 2006).

In view of the country's rapidly ageing population, the prevalence of osteoporosis is estimated to rise. In Malaysia, it is expected that the number of people over the age of 60 will increase from 1.4 in 1999 to approximately 3.3 million by 2020 (Mafauzy, 2000, Noor, 2002). Due to rapid urbanisation and economic growth in Malaysia over the last three decades, there has been a shift in the diet and lifestyle with an increase in the prevalence of chronic diseases (Tee, 1999). Thus, osteoporosis may be projected to burden the healthcare system if appropriate intervention and management is not undertaken.

Moreover, epidemiological studies have estimated an exponential rise in the incidence of osteoporosis and fractures in Asia. According to the WHO, by the year 2050, it is estimated that one out of every two people that experience a fracture in the world will live in Asia (Cooper *et al.*, 1992). In Malaysia, it is estimated that the incidence of hip fractures among individuals over the age of 50 was 90 per 100,000 and 500 per 100,000 in people over the age of 75, with direct costs from hospitalisation reaching 22 million Ringgit (approximately $ 6 million) in the year 1997 (Lee and Khir, 2007). With regards to race and the specific incidence of hip fractures in Malaysia, the results show that the incidence is higher among the Chinese (160 per 100,000) than Indians (150 per 100,000) and Malays (30 per 100,000) (Lee and Khir, 2007). Moreover, it is expected that the number of hip fractures in women will double as women are more likely to be affected than men, with 218 and 88 cases per 100,000 people, respectively (Lau *et al.*, 2001a). No Malaysian data are available on the incidence of other fractures due to osteoporosis.

According to the Asian Osteoporosis Study, the rate of hip fractures in Malaysia is lower than other in Asian countries (Lau *et al.*, 2001a). However, with urbanisation and ageing, this rate is more likely to escalate (Ross, 1996). Moreover, the total economic burden of osteoporosis and fractures in Asia has been underestimated, as most studies did not account for the costs of rehabilitation and long-term nursing care (Mithal *et al.*, 2009a). The best way to control osteoporosis is through aggressive prevention strategies targeting high-risk individuals, according to the latest Malaysian Clinical Guidance (Yeap *et al.*, 2013). As such, screening and monitoring osteoporosis can be important prevention strategies (Summers and Brock, 2005).

1.2.2 Diabetes mellitus in Malaysia

Malaysia is a multi-ethnic country with a total population of 29 million (Department of Statistics Malaysia, 2010). In Malaysia, according to the Third National Health and Morbidity Survey (NHMS-3), it was estimated that the prevalence of T2DM in individuals aged 30 years and over has increased from 8.30% in 1996 to 14.90% by the year 2006, with the greatest increase in the Indian population (Zanariah *et al.*, 2008, Letchuman *et al.*, 2010). Moreover, it is expected that the number of individuals with diabetes will rise from 1,846,000 in 2010 to 3,254,994 in 2030, and the adjusted diabetes incidence (adjusted to the world population) in Malaysia will increase from 11.6% in 2010 to 13.8% by the year 2030 (International Diabetes Federation, 2009). According to the Malaysian Ministry of Health, there has been an increase in the prevalence of chronic diseases, including diabetes, within Malaysian population (Ministry of Health Malaysia, 2009).

This increase in the prevalence of diabetes is associated with many factors, including the rapid economic growth of the country in the last few decades, urbanisation and industrialisation, which have resulted in more overweight/obese people and a sedentary life style (Ismail *et al.*, 2002, Mustaffa, 2004, Yun *et al.*, 2007, Kee *et al.*, 2008, Rashid, 2008). In Malaysia, it is estimated that the number of individuals aged 65 years and over was gradually increased from 4.3% in 2005 to 4.8% in 2007, which was much higher than the increase in younger individuals (Yahya *et al.*, 2008). In this age group, around 25% to 30% of individuals have diabetes or glucose intolerance (Wild *et al.*, 2004).

Diabetes mellitus can be controlled and managed, but it cannot be cured completely, with a combination of medical care, patient education and self-management (Ali and Jusoff, 2009, Funnell *et al.*, 2009, Ministry of Health Malaysia, 2009, Shrivastava *et al.*, 2013). Multiple diabetes complications in Malaysian T2DM patients have been found, with an incidence as high as 38% to 50% (Dhanjal *et al.*, 2001, Mimi *et al.*, 2003, Ooyub *et al.*, 2004, Mafauzy, 2006a). Out of all the patients who require dialysis in Malaysia, 57% are patients with diabetic nephropathy (Lim and Lim, 2006), and 55% of patients who suffered from stroke also had diabetes (Wong, 1999, Hamidon and Raymond, 2003). Diabetes mellitus was eighth in the list of top ten causes of death by non-communicable disease in Malaysia (Yusoff *et al.*, 2013). Many Malaysian studies that focused on diabetes showed a large proportion of patients with poor or suboptimal glycaemic control and a mean HbA1C higher than the value recommended by guidelines (Ismail *et al.*, 2000, Chuang *et al.*, 2002, Wong and Rahimah, 2004, Tan and Magarey, 2008, Kamarul Imran *et al.*, 2010).

1.3 Osteoporosis care and prevention

Osteoporosis is a major health problem in Asia. Osteoporosis may arise at any time and some of the most important risk factors that may lead to develop osteoporosis include genetics, lifestyle, nutrition, inadequate calcium intake and physical activity, vitamin D deficiency and decreased production of sex hormones (U.S. Department of Health Human Services, 2004, Yeap *et al.*, 2013). Osteoporosis causes serious medical complications, not only restricted to the immediate pain resulting from fractures, but may also cause a wide range of serious medical consequences and affect total quality of life, as shown by many Malaysian studies (Lai *et al.*, 2008, Lai *et al.*, 2013). For instance, the surgical procedure for a hip fracture may lead to

morbidity and may even cause death due to serious medical complications (Hannan *et al.*, 2001). It is estimated that up to 20% of mortality risk is associated with post hip fracture complications. In addition, 40% of patients suffer sustained disability and a loss of independence, which require long-term nursing care. Therefore, osteoporosis-related fractures are considered a major public health problem and challenge in Asia (Lau *et al.*, 2001a, Kung *et al.*, 2013). The problem is further exacerbated as the overall nutrition and economic situation in these regions have shifted over the last few decades, which has led to an excessive increase in health care costs and socioeconomic impact due to osteoporotic fractures in Asia (Gullberg *et al.*, 1997).

Adaptation of an unhealthy lifestyle such as inadequate regular physical activity and low dietary calcium intake have been found to be major risk factors for osteoporotic fractures in Asia (Lau *et al.*, 2001b). Moreover, many epidemiological studies have identified a high incidence of vitamin D inadequacy and as a results an increased incidence of osteoporosis in Asian populations (Mithal *et al.*, 2009b, Chan *et al.*, 2010, Ho-Pham *et al.*, 2011). Similar results have been found in Malaysian postmenopausal women (Rahman *et al.*, 2004). Prevention of osteoporosis should begin at birth and continues throughout the lifespan. Thus, to slow down bone loss, corrective action must be undertaken by the adaption of a healthy lifestyle including regular exercise and adequate dietary calcium intake (Chee *et al.*, 2003, Ting *et al.*, 2007, Yeap *et al.*, 2013). However, the lack of bone disease awareness in the public is one of the biggest problems in term of the prevention of osteoporosis. Moreover, there is a common misunderstanding that osteoporosis is a disease only in women and in the aged population (Mudano *et al.*, 2003, Qaseem *et al.*, 2008). As a

consequence, such an incorrect view may delay the prevention and management of osteoporosis.

The prevention of osteoporosis consists of three types: primary, secondary and tertiary prevention. Primary prevention involves general management that includes the assessment of the risk of falls and their prevention to avert the onset of disease (Chang *et al.*, 2004). It includes encouraging adequate calcium and vitamin D intake and exercise (Body *et al.*, 2011, Yeap *et al.*, 2013). Secondary prevention involves early diagnosis and prompt treatment, including fall prevention and using anabolic agents. Tertiary prevention includes comprehensive treatment of fractures and, at this level, professional healthcare efforts to retrain and rehabilitate the individual with impairments and/or disability (National Institutes of Health, 2001, U.S. Department of Health Human Services, 2004, Yeap *et al.*, 2013).

1.4 Osteoporosis knowledge, health belief and self-efficacy

1.4.1 Osteoporosis knowledge

Information pertaining to the awareness and the level of knowledge regarding bone health status and its risk factors are still very limited among adults in Asian (Nguyen and O'Connell, 2002) and in Malaysian community-based studies (Jamila *et al.*, 2010, Yeap *et al.*, 2010). The major obstacles that been identified in the management of osteoporosis included a limited level of awareness and knowledge within the population, as well as low priority to initiate an appropriate preventive and curative plan by healthcare professionals (Cinda and Sava 2004, Chang *et al.*, 2007, Giangregorio *et al.*, 2007, Yeap *et al.*, 2010). Generally, in the chronic disease

management area, increased awareness and knowledge about a disease is associated with improved patient compliance and adherence by increasing the identification of problem and awareness about the decision process (Kennedy and Rogers, 2002).

Several community-based studies have identified a low level of osteoporosis knowledge in other countries (Sedlak *et al.*, 2000a, Yu and Huang, 2003, Chang, 2004, Ailinger *et al.*, 2005, Jalili *et al.*, 2007, Chang, 2008, Aree-Ue and Petlamul, 2013). Although a good understanding of the disease condition may not be adequate to make significant changes in health-related behaviour, knowledge is still a prerequisite step for success in adopting and continuing a healthy lifestyle for preventive efforts (Gurney and Simmonds, 2007, Ozturk and Sendir, 2011). Thus, screening and prevention strategies are cornerstones of appropriate osteoporosis management, and education plays a key role in improving osteoporosis outcomes (Yeap *et al.*, 2013).

Due to the number of challenges faced by healthcare professionals to implement guidance, including a lack of osteoporosis awareness, knowledge, understanding responsibilities regarding management and restricted access to diagnostic equipment (Levine, 2011), knowledge of osteoporosis is a central part of informed decision making on the pharmacological and non-pharmacological aspects of osteoporosis management (Body *et al.*, 2011). Therefore, improved information on osteoporosis and associated fractures for the high risk populations are important osteoporosis preventive strategies. Moreover, many previous studies have shown that a well-developed educational program is essential for the improvement of osteoporosis prevention behaviour and fracture-related outcomes in terms of improving bone

health. Thus, an evaluation of the educational needs of patients is an essential first step (Piaseu *et al.*, 2001, Aree-Ue *et al.*, 2006).

1.4.2 Osteoporosis health beliefs

The osteoporosis health beliefs play central roles in osteoporosis prevention and behaviour management. Based on health belief model (HBM) theory, health behaviour is determined by personal beliefs or perceptions toward the disease and its preventive strategies (Janz and Becker, 1984). HBM is the most widely used theory in health promotion and educational programmes (Turner *et al.*, 2004). Therefore, HBM theory is used in osteoporosis research and practice (Wallace, 2002, Edmonds *et al.*, 2012). HBM theory proposes that individual prevention behaviours toward osteoporosis increase, if patients feel susceptible, believe that the occurrence of osteoporosis would have a severe impact on their lives and conclude that preventive measures are beneficial, outweighing any barriers involved in taking action (Rosenstock, 1974, Cadarette *et al.*, 2004, Hazavehei *et al.*, 2007, Painter *et al.*, 2008).

By utilising HBM theory, researchers can investigate and understanding the health behaviours and the reasons for non-compliance to osteoporosis prevention programs (Turner *et al.*, 2004). Thus, HBM has been used to explain change and provides a guiding framework for health behaviour interventions (Glanz *et al.*, 2008). Many osteoporosis research studies utilise this model to plan and intervene in populations at risk of having osteoporosis in an attempt to determine which variables lead some individuals to engage in healthy behaviours and which variables hinder a person's performance (Sedlak *et al.*, 2000a, Chan *et al.*, 2007). In Asia, many studies have

shown that most individuals have low osteoporosis health beliefs and they do not engage or practice in preventative measures for osteoporosis, which places them at a higher risk of low bone mass accruals, even though they are aware that they are vulnerable to the risk of osteoporotic fractures in later life (Nguyen and O'Connell, 2002, Lee and Lai, 2006, Aree-Ue and Petlamul, 2013, Kim *et al.*, 2013). A better understanding of the interactions of all these aspects of knowledge, beliefs, dietary and lifestyle practices in relation to positive bone health status and osteoporosis prevention among individuals will ultimately help them to make a better decisions on how to maximise their bone mass during earlier stages of life in order to prevent the risk of osteoporosis in later life.

1.4.3 Osteoporosis self-efficacy

Self-efficacy is refers to an individual's confidence about their ability to perform a particular behaviour successfully (Bandura, 1977, Bandura, 2004). Therefore, self-efficacy determines how people think, feel, motivate and behave toward disease. Individuals with greater self-efficacy are more likely to motivate and engage in healthy behaviours and maintain these behaviours for more positive outcomes and less negative outcomes (Luszczynska *et al.*, 2005). The self-efficacy building process includes an interaction between emotional states, motivation and outcome expectancy (Bandura and Adams, 1977). Self-efficacy contributes to motivation by helping people to determine their goals, how much effort they expend, how long they persevere in the face of difficulty and their resilience to failures.

Osteoporosis educational intervention programmes is crucial to enhancing knowledge and prevention behaviour regarding osteoporosis; as well, it creates the

precondition for health behaviour changes (Piaseu *et al.*, 2001). In general, the individuals is more likely motivated to act when they realise that changing their behaviour is beneficial to reducing the risk of osteoporosis. This motivation is very important in self-efficacy theory (Laslett *et al.*, 2004). Many osteoporosis studies have shown that self-efficacy is considered one of the best predictors of health behaviours, particularly in terms of increasing physical activity and dietary calcium intake (Wallace and Ballard, 2002, Jones *et al.*, 2005, Hsieh *et al.*, 2008). Moreover, many community-based studies have shown low self-efficacy toward osteoporosis (Piaseu *et al.*, 2001, Brecher *et al.*, 2002, Doheny *et al.*, 2010, Ozturk and Sendir, 2011, Khorsandi *et al.*, 2012, Aree-Ue and Petlamul, 2013). Therefore, increasing self-efficacy perceptions toward osteoporosis are of significant importance in osteoporosis preventive behaviours (Sedlak *et al.*, 2000a).

1.5 Research Problems

Diabetes and osteoporosis management is a lifelong process that requires effort from healthcare providers and patients. However, the patient is the key to successful management, and serious complications can result from poor management. Patients must be proficient to successfully manage, maintain lifestyle changes and make daily decisions for better health, while the healthcare professional has the responsibility to help patients to make the right decisions and cope with the difficulties and barriers through education, support and advice (Funnell and Anderson, 2004, Levine, 2011).

This study has illustrated the following problems:

1. The proportion of low bone mineral density is high among the general population in Asia. As well, the prevalence of osteoporosis in

postmenopausal women in Malaysia is also high. In Malaysia, there has been a shortage of data on the topic of the prevalence of osteoporotic conditions among T2DM patients.

2. To date, there have been few academic and empirical published papers regarding osteoporosis knowledge, health belief and self-efficacy, and most of the reviews on this subject have been conducted in western countries. In Malaysia, there has been a lack of data on the topic of patient knowledge, health beliefs and self-efficacy regarding osteoporosis among T2DM patients.
3. No validated Malaysian tools have been found for the assessment of osteoporosis knowledge, health beliefs and self-efficacy among T2DM patients.
4. Scarce results have been published regarding the association of bone mineral density measurement and osteoporosis knowledge, health beliefs and self-efficacy in patients with T2DM.

1.6 Rationale of the study

Osteoporosis is a growing health problem in Malaysia with a high cost in terms of economics and disability. In Malaysia, it is estimated that 27,000 people break a hip every year because of osteoporosis. The hip fracture incidence among individuals aged 50 years and over was 90 per 100,000 with 22 million Ringgit direct hospitalisation costs in the year 1997. In addition, it is estimated that the number of hip fractures in females is double compared to males (Lau *et al.*, 2001a, Lee and Khir, 2007). The prevalence of osteoporosis in Malaysia was 24.10% in 2005, which is considerably higher than other Asian countries (Loh and Shong, 2007). This may

be due to rapid socio-economic growth, enormous urbanisation and changes in dietary habits.

In all countries studies reviewed, there is evidence of underdiagnosed and underestimated osteoporosis among the general population (Vestergaard *et al.*, 2005, Haussler *et al.*, 2007) and among diabetic patients (Abdulameer *et al.*, 2012c, Luft, 2012). Many studies have shown that T2DM is related to various skeletal disorders, including osteoporosis and osteopenia (Thrailkill *et al.*, 2005, Abdulameer *et al.*, 2012c, Hamann *et al.*, 2012). Moreover, it has long been known that alterations in bone and mineral metabolism are clinically complicated in patients with diabetes mellitus (Levin *et al.*, 1976, Ishida *et al.*, 1985, Piepkorn *et al.*, 1997). Many studies findings have shown a loss of bone mass that consequently leads to decreased BMD and osteoporosis among T2DM patients with poor glycaemic control (Krakauer *et al.*, 1995, Linda *et al.*, 2003, Majima *et al.*, 2005). Several mechanisms have been proposed for diabetes-related osteoporosis. These include both the co-morbidities of diabetes and the more direct pathophysiological effects of the disease itself (Lenchik *et al.*, 2003, Inzerillo and Epstein, 2004).

Furthermore, patients with T2DM frequently do not adhere to their prescribed medications and, consequently, poor glycaemic control can result, with an increased incidence of diabetic complications, increased morbidity and mortality and increased health care facilities utilisation (Delamater, 2006, Fowler, 2008, Ahmad *et al.*, 2013). Thus, encouraging diabetes self-management and improved glycaemic control play a key role in decreasing and protecting bone mass loss in T2DM patients (Gregorio *et*

al., 1994, AL-Elq and Sadat, 2006, Xu *et al.*, 2007, Al-Zaabi *et al.*, 2008, Tao *et al.*, 2008).

Although numerous measures have been taken to improve bone health and osteoporosis management through published Malaysia guideline (Yeap *et al.*, 2013), there is a lack of good bone health control and osteoporosis management. In Malaysia, it is important to explore patient knowledge, health beliefs and self-efficacy toward osteoporosis and their awareness by identifying the source of information. It is also imperative to understand the contribution of osteoporosis knowledge, health beliefs and self-efficacy among T2DM patients regarding bone mineral density measurements to promote better osteoporosis prevention behaviour.

Lack of awareness and proper osteoporosis management are responsible for the high prevalence of low bone mass (Patel *et al.*, 2004, Winzenberg *et al.*, 2005, Doheny *et al.*, 2007, Spencer, 2007). Thus, it has been recommended that osteoporosis education should be a component of the diabetes management process by the health system as diabetes is a risk factor for developing osteoporosis (Brown and Sharpless, 2004). Most of the interventions that attempt to improve osteoporosis knowledge, health beliefs and self-efficacy in community-based studies were educational programs; therefore, for a proper intervention that leads to changes in patient behaviour, it is important to first evaluate osteoporosis knowledge, health beliefs and self-efficacy among T2DM patients. Osteoporosis prevention behaviour and education must be adjusted to the level of knowledge of the patients and should be culturally sensitive.

1.7 Significance of the study

As a result of the rapidly growing prevalence of diabetes and osteoporosis with the evidence that normal bone mineral density (healthy bone) among T2DM patients is associated with reduced morbidity, mortality and disability, osteoporosis prevention behaviours have been considered an important part of the management of patients with T2DM (Janghorbani *et al.*, 2007, Luisa Isidro and Ruano, 2010, Luft, 2012). Currently, osteoporosis is considered a problem in women as well as in men, and particularly in elderly persons.

Many educational interventions program for osteoporosis prevention have been offered to and evaluated in community level studies. However, osteoporosis in the clinical setting is still underdiagnosed, undertreated, under-reported and inadequately researched. Even among the Malaysian population with a high risk of osteoporosis, the population reported significantly fewer osteoporosis diagnoses than other Asian populations (Kung *et al.*, 2013). In Malaysia, elderly patients with osteoporosis-related fractures are at greater risk for increased disability, high annual costs of healthcare, loss of productivity and quality of life; this is a major issue that has to be dealt with (Lau *et al.*, 2001a, Seng-Kim, 2009, Yusoff *et al.*, 2013). Therefore, screening people with high risk factors of developing osteoporosis like T2DM is considered crucial for preventing osteoporosis progression and related fractures.

If no comprehensive prevention strategies are implemented, the prevalence of osteoporosis and fractures is estimated to increase by double or triple by 2040 (Morris *et al.*, 2004, Burge *et al.*, 2007). Many studies have reported that osteoporosis-related fractures tend to result in significant morbidity, mortality and

financial expense (Caliri *et al.*, 2007, Qaseem *et al.*, 2008, Becker *et al.*, 2010). Lifestyle behaviours that influence the development of healthy bones included adequate exercise, weight control, balanced nutrition, and adequate calcium and vitamin D intake (Elgan *et al.*, 2005, Morgan, 2008, Gracia-Marco *et al.*, 2011, Yeap *et al.*, 2013). Health beliefs often influence these lifestyle choices (Sadler and Huff, 2007). Primary prevention strategies need to be increased and targeted toward groups at high risk of developing osteoporosis. Although osteoporosis is considered an inevitable disease, it is still vitally important to take effective action to deal with this disease, such as a balanced diet containing calcium-rich food and engaging in regular physical activity (Levine, 2006, Tung and Lee, 2006). Assessing osteoporosis knowledge and the extent to which preventive health behaviours are practiced among T2DM patients will give a better comprehensive evaluation of osteoporosis management.

However, little is known regarding specific osteoporosis awareness, knowledge, health beliefs and self-confidence needed for T2DM patients to effectively participate in prevention behaviours. Therefore, the assessment of these is important for improving T2DM patient outcomes. This study will attempt to discover the association between osteoporosis knowledge, health beliefs and self-efficacy among T2DM patients and bone health status. Moreover, there is a lack of research concerning osteoporosis knowledge, health beliefs and self-efficacy among T2DM patients of both genders and multiple races. This may stem from the majority of research being conducted in these areas among healthy individuals or postmenopausal elderly women.

At the end of this study, healthcare professionals and authorities will have a clearer picture of the problems related to osteoporosis in T2DM patients. This study will explore patient perceptions of osteoporosis, identify patients with poor osteoporosis knowledge, health beliefs and self-efficacy, as well as identify patients with low bone mass. The results will help in future planning of educational programs for patients with diabetes and help health care providers to concentrate on those patients with high risk factors for developing osteoporosis or low bone mass.

1.8 Research objectives and questions

1.8.1 Objective of the study

Osteoporosis among T2DM patients is a major public health problem that requires urgent attention. Patients often do not consider the diabetic condition to be a risk factor affecting bone health. Thus, it is important to understand the contribution of knowledge, health beliefs and self-efficacy in order to provide better care and prevention. To date, scarce data have been published in terms of the assessment of osteoporosis knowledge, health beliefs and self-efficacy, as well as its prevalence in T2DM patients. Therefore, further exploration of the association between osteoporosis knowledge, health beliefs and self-efficacy and the effect of these factors on bone mineral density measurement is needed. The principal purpose of the study was to investigate the prevalence of low bone mass and to assess osteoporosis knowledge, health beliefs and self-efficacy and the association of these factors on bone health. The study findings may provide the healthcare system with a better understanding of the risk of diabetic disease on bone health status, as well as the

effect of osteoporosis knowledge, health beliefs and self-efficacy on bone mineral density measurements in patients.

The specific aims of this study are:

1. To determine the prevalence of low bone mineral density (LBMD, i.e., osteopenia and osteoporosis) in T2DM patients using quantitative ultrasound method (QUS).
2. To assess the difference in QUS parameters of the calcaneus stratified by age and gender.
3. To evaluate the correlation between QUS parameters and T-score values with patient demographic characteristics, diabetes-related data, and lipid and blood pressure profiles.
4. To evaluate the association between QUS-score (normal BMD, osteopenia and osteoporosis) and demographic characteristics, diabetes-related data, lipid and blood pressure profiles.
5. To translate, validate and assess the psychometric properties of the chosen tools for the assessment of osteoporosis knowledge, health beliefs and self-efficacy.
6. To assess the level of osteoporosis knowledge, health beliefs and self-efficacy among patients with type 2 diabetes.
7. To assess the correlation and differences of demographic characteristics, diabetes-related variables as well as lipid and blood pressure profiles with osteoporosis knowledge, health beliefs and self-efficacy.
8. To assess the correlation between osteoporosis knowledge, health beliefs and self-efficacy scales and subscales.

9. To assess the correlation between T-score values using QUS and osteoporosis knowledge, health beliefs and self-efficacy.
10. To assess the potential factors that predicts the QUS measurement score in T2DM patients.

1.8.2 Research questions

The study addressed the following questions:

1. Is there a high prevalence of low bone mineral density? What is the percentage of osteopenia and osteoporosis in T2DM patients?
2. Is there a deficiency in osteoporosis knowledge, health beliefs and self-efficacy among patients with T2DM?
3. Which of the three variables (osteoporosis knowledge, health beliefs and self-efficacy), including interactions between variables, account for the most variance in predicting bone mineral density measurements?
4. What is the type and strength of the relationship between patient characteristics and osteoporosis knowledge, health beliefs and self-efficacy, as well as the outcome (normal bone mineral density)?

1.9 Thesis overview

In this thesis, chapter 2 reviews the literature related to the study with the definition of terms and provides a conceptual framework. A thorough review of literature relevant to the study, focusing on the possible relationship between osteoporosis and diabetes elsewhere in the world form the bulk of this chapter. The chapter continues with an overview of the beneficial use of osteoporosis knowledge, health beliefs and self-efficacy in research studies.